IN THE DRAWINGS:

Please substitute the attached Replacement Sheet(s) for its(their) corresponding drawing sheet(s) in this Application.

REMARKS

Favorable reconsideration of this application is requested in view of the foregoing amendments and the following remarks. Claims 1-33 are pending in the application.

Independent claims 1 and 12 are amended to require realizing a constant spread-spectrum process gain to uniformly reject cross-user interference by using groups (#k, #k+1) of spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in the set. Independent claims 22 and 27 are amended to require a constant spread-spectrum process gain that uniformly rejects cross-user interference by using groups (#k, #k+1) of spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers. Explicit support for these limitations is found in the specification as originally filed. Specifically, the phrase "a constant spread-spectrum process gain to uniformly reject cross-user interference" is supported in paragraph 0016 (see also paragraph 0020). The phrase "groups (#k, #k+1) of spectrally overlapping multiple OFDM carriers" is supported in paragraphs 0018 and 0019. At page 2 of the Action the specification is objected to. The specification is amended as suggested by the Examiner.

Accordingly, withdrawal of this objection is respectfully requested.

At pages 2-3 of the Action the drawings are objected to. Figure 3 is amended as suggested by the Examiner.

Accordingly, withdrawal of this objection is respectfully requested.

At pages 3-4 of the Action, claims 1-20 are rejected under 35 USC 112(1) as not enabled. As noted above, independent claims 1 and 12 are amended to recite realizing a constant spread-spectrum process gain to uniformly reject cross-user interference by using groups (#k, #k+1) of spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in the set. The phrase "a constant spread-spectrum process gain to uniformly reject cross-user interference" is supported in paragraph 0016 (see also paragraph 0020). Also, the phrase "groups (#k, #k+1) of spectrally overlapping multiple OFDM carriers" is supported in paragraphs 0018 and 0019. All of claims 1-20 are method claims and they do not recite means under 35 USC 112(6) (see the first sentence of paragraph 0041).

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 1-2 and 5 were rejected under 35 USC 102(e) as unpatentable over Mottier (2006/0029012). As noted above, independent claim 1 is amended to recite realizing a constant spread-spectrum process gain to uniformly reject cross-user interference by using groups (#k, #k+1) of spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in the set. The Mottier reference does not disclose or suggest spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in the set.

The specification of this application describes a methodology of generating and receiving fully (or largely) overlapping spread-spectrum signals, using hybrid CDMA-OFDM techniques. In the claimed invention, carriers of an otherwise conventional OFDM set are individually spread by means of Walsh (or other essentially orthogonal) code polynomials. For instance, in a nominal Walsh set of 16, each OFDM carrier, once generated via conventional means, is *subsequently* spread using the 16-length Walsh code and binary-multiplied (EXORed) by a conventional pseudonoise (PN) overlay code to achieve a constant carrier-to-carrier spreading bandwidth (or spectrum). Since each original OFDM carrier is mutually orthogonal with the others in the set, and since the Walsh codes are also by nature mutually orthogonal with the others in the Walsh set, then the product of the Walsh codes and the OFDM carriers is also mutually orthogonal with all other code products in the set. The final multiplication by the common (or separate) PN overlay code does not materially affect this mutual orthogonality among the specialized hybrid CDMA-OFDM carriers of the invention but does assure a constant post-spreading bandwidth for all the signals in the set. The degree of spectral overlap of the hybrid CDMA-OFDM signals is high, up to ${}^{(N-1)}/_{N}$ [where N is the polynomial length], e.g., ${}^{15}/_{16}$ as illustrated in the examples in the specification of this application [paragraphs 0019, 0021, 0026, and Fig. 1].

A unique advantage of the claimed invention, which is ***not*** disclosed in any of the cited reference documents, is that the signals of the invention, as a group, are <u>significantly less affected by multipath signals, narrowband interference, and broadband (e.g., impulse) noise than conventional OFDM signals</u>. This is due to the added effects of the spread-spectrum process gain achieved by the Walsh (or other) spreading codes, which provides an effective reduction [equal to the length of the spreading code – here, by a factor of 16 (or 12 dB)] in the

uncorrelated signals in the receiver of the invention. The magnitude of the additional mutual access interference (MAI) caused by the orthogonal post-spreading of the OFDM carriers is essentially zero, since all operations are performed in a fully-orthogonal, phase-synchronous manner. ***Thus, the signals of the claimed invention have significant benefits over conventional "CDMA-OFDM" signals but are not explicitly described in the cited documents and are therefore novel.***

Mottier discloses a method for "optimally" (at least according to his definitions of valid cost functions) assigning codes for a multi-user MC-CDMA system, where the stated purpose is to minimize the received signal component which is related to the interference from the other users in the system [paragraphs 0022-0023]. Due to signal-to-noise constraints in receiving signals in real (i.e., noise + multiuser interference) environments, the optimization does not absolutely minimize the multiple-access interference due to the true random noise, but does get close. The minimized cost function describing the inter-user interference is then used to *wisely* choose which polynomials out of a standard set to select for the existing users, allowing for the addition of a *limited* number of future users to be added without noticeable system degradation [paragraphs 0030-0041]. The code set actually used thus varies dynamically with the signal environment (noise, interference, frequency-selective fading, etc.) [paragraphs 0042-0045]. Mottier, however, does ***not*** employ a grouped partitioning of the possible orthogonal code set, as disclosed in the instant invention. The code sets of the claimed invention are essentially fixed to minimize inorthogonalities (crosstalk) between neighboring carriers (signals). Mottier fails to teach or even mention such an orthogonal assignment, but rather discloses a dynamic code-assignment scheme for a very general MC-CDMA system to minimize the overall (costed) mutual degradation (interference) among all users of the system. Mottier discloses methods

using Walsh, Gold, ***or*** Kasami sequences, but never at any time teaches or even alludes to the ***simultaneous***, ***concatenated*** use of Walsh codes with Gold or other codes as does the claimed invention. The claimed invention, on the other hand, is expressly intended to provide a constant direct-sequence (DS) process gain for largely overlapping signals, derived from OFDM-like carrier-frequency sets.

In summary, none of the cited references disclose the specific combination of Walsh or other forms of orthogonal coding over selected groups of OFDM signals within a set with the high degree of spectral overlap as described in the instant case, the specific forms of concatenated coding to meet FCC ISM-band regulations, nor do they recite the significant process gain advantages (equal to the spreading-code length) available to the hybrid CDMA-OFDM user of the instant invention, namely the simultaneous rejection of multipath, narrowband and wideband RF interference, and noise.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 1-2, 5, 7-9, 12-13, 16, 18-19, 22 and 27 were rejected under 35 USC 102(b) as unpatentable over Hara et al. "Overview of Multicarrier CDMA", IEEE 1997. As noted above, independent claims 1 and 12 are amended to recite realizing a constant spread-spectrum process gain to uniformly reject cross-user interference by using groups (#k, #k+1) of spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in the set. As noted above, independent claims 22 and 27 are amended to require a constant spread-spectrum process gain that uniformly rejects cross-user interference by using groups (#k, #k+1) of spectrally

overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers. The Hara reference does not disclose or suggest spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers.

The literature-survey document by Hara describes several basic CDMA and CDMA-OFDM schemes (with OFDM referred to as MC [multicarrier]). After comparison with the standard textbook single-carrier CDMA spread-spectrum, the authors recite generic BPSK schemes for transmitters and receivers for multicarrier CDMA (MC-CDMA) [Figs. 2, 3]), multicarrier DS-CDMA [Fig. 4], and multitone CDMA (MT-CDMA) [Fig. 5] systems. Also included are bit-error and bandwidth characteristics for each of these types of basic CDMA-OFDM signals. The MC-CDMA scheme of Fig. 2, displayed for the *j*th user of a group, reveals a standard MC (OFDM) transmitter, in which the data stream to each OFDM carrier consists of a user bit which is binary-multiplied (EXORed) with a different (time-successive) chip in the *j*th user's code sequence for each OFDM carrier. This is effectively just a standard OFDM setup with pre-processed data streams (one per OFDM carrier), where the *j*th user's data is split among the OFDM carriers in parallel; the receiver structure is thus also completely conventional, except for the final downstream data de-multiplexing to reconstruct the *j*th user's serial data stream. <u>The maximum possible spectral overlap fraction among the OFDM carriers</u>

is ½, which is also totally standard. Fig. 3 of Hara depicts a modified form of MC-CDMA, where in the transmitter the *j*th user's data is split by a serial-to-parallel converter into 2 or more parallel sub-streams (4 depicted), where each is as in Fig. 2 EXORed *in parallel* by a corresponding respective chip in the user's code polynomial (MC chips wide). Again, this is still a standard OFDM modulator with pre-processed data, where the user's data is spread in parallel among the OFDM channels to achieve a lower effective symbol rate and, thus, ostensibly better tolerance to multipath delay spread in the signal propagation path. Fig. 4 shows the transmitter and receiver for the so-called MC-DS-OFDM scheme, where the *j*th user's data is first serial-to-parallel (S/P) converted (as before), then spread by the same time-sequential (*serial*) user code chips applied to each channel, as opposed to the parallel code spreading (different, successive chips) used in the MC-CDMA techniques for Figs. 2 and 3. As before, the maximum possible spectral overlap fraction among the OFDM carriers is ½, which again is totally standard. The receiver is complementary, with a final parallel-to-serial (P/S) conversion to extract the *j*th user's data. Once again, the standard maximum overlap fraction (½) applies. Finally, in Fig. 5 the MT-CDMA scheme is shown, where the *j*th user's data is first S/P converted and then spread by a ***common*** *j*th time-domain code sequence before being modulated onto the OFDM carrier set. The resulting OFDM signals may no longer be very orthogonal [Hara, page 128, column 2, lines 10-12] unless the user codes are carefully selected; no mention is made of the use of a family of Walsh or other orthogonal codes (as in the instant case) to improve the inter-carrier orthogonality of the resulting transmitted CDMA-OFDM set, nor of the specific advantages thereof. ***Since Hara fails to disclose either the specific methodology of the use of families of overlaying Walsh or equivalent orthogonal codes (i.e., different codes in successive channels) in OFDM systems, the higher***

degrees of signal overlap possible (i.e., >½), or the operational advantages (i.e., multipath, noise, and interference rejection) achieved thereby, Hara clearly does <u>not</u> anticipate the claims of the instant invention.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 3 and 14 were rejected under 35 USC 103 as obvious over Hara et al. "Overview of Multicarrier CDMA", IEEE 1997 in view of Finkelstein (6,014,446). The Hara and Finkelstein references do not disclose or suggest, alone or in combination, spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers.

Finkelstein discloses methods to design more secure (i.e., nonlinear structures for linear-feedback shift registers (LSFRs) and linear congrential generators (LCGs). Standard LFSR and LCG circuits or software techniques are by definition linear and thus are vulnerable to cryptographic attack (not secure). Finkelstein discloses methods of combining multiplicative elements in the otherwise linear structures which add the desired encryption strength to the output codes, generally in a form:

$$x(n+1) = x(n)*R1+R2 \bmod R3$$

where R1-R3 are LSFRs, in which the tap positions (to develop different codes) are controlled by a fourth LSFR, R4. The output of Finkelstein's structure is cryptographically secure (at least reasonably so). However, Finkelstein *at no time* discloses either the specific methodology of the instant case of the use of families of overlaying Walsh or equivalent orthogonal codes (i.e., different codes in successive channels) in OFDM systems, the higher degrees of signal overlap

possible (i.e., >½), or the operational advantages (i.e., multipath, noise, and interference rejection) achieved thereby.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 4 and 15 were rejected under 35 USC 103 as obvious over Hara et al. "Overview of Multicarrier CDMA", IEEE 1997 in view of Dinan et al. "Spreading codes for direct sequence CDMA and wideband CDMA cellular networks", IEEE 1998. The Hara and Dinan references do not disclose or suggest, alone or in combination, spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers.

Dinan is a tutorial and survey article describing several standard-art data-spreading techniques for CDMA and W-CDMA systems as used in modern cell-phone and data systems. Dinan discloses standard Maximal-length (MLS), Gold, and Kasami sequences and their basic properties, as well as the selection criteria for their use in industry-standard CDMA (IS-95) and developing W-CDMA systems. Fixed- and variable-length orthogonal codes are also covered, in terms of their mathematical properties and applications in the commercial CDMA and upcoming commercial W-CDMA systems. However, Dinan <u>fails to disclose at any time any aspect of OFDM at all</u>; <u>further, he teaches nothing</u> on either the specific methodology of the instant case of the use of families of overlaying Walsh or equivalent orthogonal codes (i.e., different codes in successive channels) in OFDM systems, the higher degrees of signal overlap possible (i.e., >½), or the operational advantages (i.e., multipath, noise, and interference rejection) achieved thereby.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 6 and 17 were rejected under 35 USC 103 as obvious over Hara et al. "Overview of Multicarrier CDMA", IEEE 1997 in view of Chang et al. "Wavelet-Based multicarrier CDMA for personal communications system", IEEE 1996. The Hara and Chang references do not disclose or suggest, alone or in combination, spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers.

Chang discloses a method of MC-CDMA communications based on three distinct types of wavelet-based functions – wavelet-based MC/BPSK-CDMA, MC/QPSK-CDMA, and fractal MC-CDMA. The advantages of these wavelet-based signals are nil compared to standard MC-CDMA modulations in a Gaussian white-noise environment, but due to their frequency diversity and the fact that the wavelet pulses can be specifically tailored for realistic multipath channels, a higher bandwidth efficiency can be obtained than with conventional binary signals. Wavelet-based MC-CDMA is thus presented as a promising technique for future broadband wireless systems. However, the paper of Chang does not at any point address the application of a hybrid-coded OFDM-CDMA scheme as in the instant case; further, he fails to disclose any specifics of the overlapping Walsh-overlay coding of OFDM signals and/or concatenated coding (and advantages thereof), and thus does not teach the salient aspects of the instant invention or anticipate same.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 10-11, 20-21, 24-26, 28-29 and 31-33 were rejected under 35 USC 103 as obvious over Hara et al. "Overview of Multicarrier CDMA", IEEE 1997. As noted above, the Hara reference does not disclose or suggest spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers.

Accordingly, withdrawal of this rejection is respectfully requested.

Claim 23 was rejected under 35 USC 103 as obvious over Hara et al. "Overview of Multicarrier CDMA", IEEE 1997 in view of Dent (6,680,928). The Hara and Dent references do not disclose or suggest, alone or in combination, spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers.

Dent discloses a method for redundantly coding channel data using a combination of error-correction coding and a spread-spectrum access code. The message is modulated and sent through at least two frequency channels or bands using a weighted sum of all user signals foe each channel. The same signals are summed for transmission on the other frequency channel(s), but using weighting factors having a progressive phase rotation (delay) relative to their values on the first channel. The sequences of weighting values for one signal are preferably orthogonal to those of the other signals. At the receiver of Dent, the process is reversed, providing good error performance in fast fading and high- multipath transmission

channels. ***However, Dent totally fails to teach the application of a hybrid-coded OFDM-CDMA scheme as in the instant case***; further, he fails to disclose any specifics of the overlapping Walsh-overlay coding of OFDM signals and/or concatenated coding (and advantages thereof), and thus does not teach the claimed invention.

Accordingly, withdrawal of this rejection is respectfully requested.

Claim 30 was rejected under 35 USC 103 as obvious over Hara et al. "Overview of Multicarrier CDMA", IEEE 1997 in view of Kim (6,035,008). The Hara and Kim references do not disclose or suggest, alone or in combination, spectrally overlapping multiple OFDM carriers, each orthogonally spaced, which are spread with successive orthogonal polynomials in recurring or rotating sequences to provide a doubly orthogonal relationship between adjacent and neighboring carriers in a set of individually spread-spectrum modulated orthogonal frequency division multiplexed carriers.

Kim discloses a wide-range, high-resolution automatic gain-control (AGC) system for DS communication systems employing fairly conventional, simple, but relatively inexpensive hardware. The principal advantage of the system of Kim lies in the use of multiple inputs to rapidly and "intelligently" perform the front-end AGC action for the half-duplex receiver, in which the received signal-strength indicator (RSSI) level, the logical carrier-sense signal (CRS), and the receiver-enable (RX_EN) signals are all used to optimally control the AGC. In addition, the unit provides low-pass filtering to the receiver's local oscillator to remove harmonics and thus reduce system noise levels. The Examiner has simply used Kim as an example of standard receiver circuitry, but Kim in no way discloses, either alone or in combination with Hara, any specifics of the overlapping Walsh-overlay coding of OFDM signals and/or concatenated coding (and advantages thereof).

Accordingly, withdrawal of this rejection is respectfully requested.

Other than as explicitly set forth above, this reply does not include acquiescence to statements in the Office Action. In view of the above, all the claims are considered patentable and allowance of all the claims is respectfully requested. The Examiner is invited to telephone the undersigned (at direct line 928-226-1073) for prompt action in the event any issues remain that prevent the allowance of any pending claims.

In accordance with 37 CFR 1.136(a) pertaining to patent application processing fees, Applicant requests an extension of time from May 21, 2007 to July 21, 2007 in which to respond to the Office Action dated February 21, 2007. A notification of extension of time is filed herewith.

The Director of the U.S. Patent and Trademark Office is hereby authorized to charge any fees or credit any overpayments to Deposit Account No. 50-3204 of John Bruckner PC.

Respectfully submitted,

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